KAY ELEMETRICS CORP.

Mega-Node Noise Source

Model 403A

INSTRUCTION MANUAL

Issue A

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Mega – Node
403A

5104-0306

We urge customers to use caution when operating or repairing an instrument. Use instruction manual for correct operating procedures and repair. Pay close attention to the decals on Kay's equipment where voltage is located. This is for your safety.

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SECTION I
GENERAL DESCRIPTION

A. DESCRIPTION.

The **MEGA-NODE 175-A** is a calibrated random noise generator consisting of two 5722 noise diodes operating in a balanced arrangement. This makes full use of the distributed parameters of each diode to achieve a balanced wide band noise output characteristic.

The **MEGA-NODE 175-A** is ideally suited for measuring either absolute or comparative noise figures of balanced input television tuners or receivers, since it may be connected directly to their input terminals. When used in this manner, no balun is required. It is also useful in laboratory and production work for rapid measurement of noise figures in db as well as for comparative measurements of sensitivity and bandwidth.

The **MEGA-NODE 403-A** noise generator is a calibrated random noise source providing an unbalanced 50 ohm output over a wide frequency range. It is a self-contained unit consisting of a power supply and a noise generator section.

It is designed for laboratory and production work for rapid measurement of noise figures directly in db; it also may be used as a signal source for the accurate calibration of attenuators and for the measurement of receiver bandwidth and relative sensitivity.

B. FEATURES.

The **MEGA-NODES 175-A & 403-A** employ two noise diodes with tungsten filaments as a temperature-limited fluctuation noise generator. The d-c plate and filament voltages for the diodes are obtained from two separate, line voltage regulated, full wave selenium rectifiers. This reduces hum modulation of noise power output to a minimum.

The diode current, which is proportional to noise power output, is adjusted by the COARSE and FINE LEVEL controls on the front panel. This current is indicated by the front panel meter, calibrated in milliamperes and noise figure in db.

The output circuitry has been designed for low VSWR at the output terminals over the specified frequency ranges.

C. SPECIFICATIONS.

FREQUENCY RANGE: *Model 175-A* - 50-500 mc.
Model 403-A - 3-500 mc.

OUTPUT IMPEDANCE: *Model 175-A* - Nominal 300 ohms balanced, untuned. *Model 403-A* - 50 ohms unbalanced, Type N connector.

NOISE FIGURE RANGE: 0 to 20 db.

METER CALIBRATION: Linear in current, 0-10 and 0-100 ma. Logarithmic in noise figure, 0-9 and 8-20 db.

ACCURACY: *Model 175-A* - ±0.5 db below 400 mc. *Model 403-A* - ±0.5 db over entire frequency and output range.

TUBES: Two #5722 Sylvania noise diodes.

POWER SUPPLY: Input approx. 50 watts, 117 volts (±10%), 60 cps a-c (50 cps on special order) plate supply regulated.

DIMENSIONS: 19¼" x 10¼" x 9½".

WEIGHT: 30 lbs.

D. ADDITIONAL EQUIPMENT REQUIRED.

1. Power level measuring device (square law r-f voltmeter, thermocouple power meter or bolometer power meter).

or

A-C voltmeter (whose law is unknown) plus a 3 db pad with a switching arrangement to select the pad as desired.

or

Any a-c voltmeter and detector, for relative measurements of noise.

or

A vacuum tube voltmeter and log-log graph paper for performing noise figure measurements at or near maximum output capabilities of the **MEGA-NODES.**

2. Low noise amplifier, where device under test has insufficient output to deflect a power level indicator.

3. Hum filter (60 or 120 cps), bridge-type.

4. Interconnecting cables, shielded where low levels are involved (RG-8/U is recommended).

SECTION II
INSTALLATION

A. GENERAL.

The MEGA-NODES are designed for table-top operation and thus present no special installation problems. The unit may be removed from the cabinet and installed in a standard 19" rack. To insure optimum operation, the equipment should not be subjected to excessive moisture, vibration, or temperature conditions.

The unit requires connections to a 117 volt, 60 cps, power source and to the device under test. Cabling to the device under test must be as short as possible and properly terminated (RG-8/U transmission line is recommended).

B. INTERCONNECTION DATA.

The type of output measuring device and other auxiliary equipment employed will determine the method of interconnection. It is advised that before selecting a method of measurement, the sections on operation techniques and noise measurement theory first be reviewed. (Sections III and IV.)

1. POWER LEVEL METER CONNECTIONS. *Figure 2* illustrates the method of connecting the MEGA-NODE and the device under test to a power level measuring instrument. If the device under test is a receiver, the connection should be made at a point following the i-f amplifier stages but before the limiter, if on an FM receiver, or second detector, if on an AM receiver.

The amplifier shown in *Figure 2* may be omitted if the receiver's i-f amplifier output is sufficient to operate the power level meter. In using an amplifier following the receiver under test, it is important that the amplifier respond to the i-f frequency of the receiver under test and have a flat band-pass capability to include the bandwidth of the receiver's i-f amplifier.

2. AC VOLTMETER AND FIXED PAD CONNECTIONS. When a power level meter is unavailable, the fixed pad method may be employed for noise figure measurements; this method requires any available type of a-c voltmeter as an indicating device (the voltmeter law is not significant in this method). Connect the equipment as shown in *Figure 3*.

In designing the attenuator pad and setting-up the switching arrangement, the terminating impedance of the amplifier must be considered. In addition, the band-pass characteristics of the attenuator must be flat over the entire bandwidth of the device under test.

In this method, the output meter is connected following a detector circuit. Therefore, any hum (due to insufficient supply filtering or stray fields) present in the output of the receiver or amplifier will be indicated on the a-c voltmeter, resulting in inaccurate noise figure measurements.

To avoid this, a bridge-type 60 or 120 cps filter (depending upon type of power supply rectifier circuit) should be employed; connect as shown in *Figure 3*.

3. AC VOLTMETER CONNECTIONS (RELATIVE NOISE MEASUREMENT). This method, as shown in *Figure 4*, while not useful in determining noise figure, permits relative measurements of noise for comparison of various circuit changes, etc. As in the fixed pad method, a detector and hum filter are employed.

4. LOG-LOG GRAPHICAL METHOD CONNECTIONS. This method is recommended for noise figure measurements where the output capabilities of the MEGA-NODE are less than the minimum requirements for the preceding methods.

When employing the log-log graphical method, the MEGA-NODE output should be connected to the input of the device under test and the output connected to a diode-type detector. If the device under test is an AM receiver, the receiver's second detector may be used, providing it is a diode type. A d-c vacuum tube voltmeter should be connected across the diode's load resistor to read the d-c output of the detector. A detailed operating procedure for the log-log method is included in Section III.

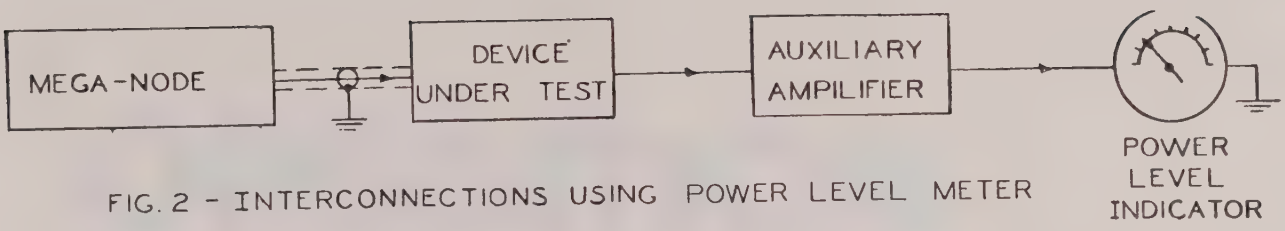


FIG. 2 - INTERCONNECTIONS USING POWER LEVEL METER

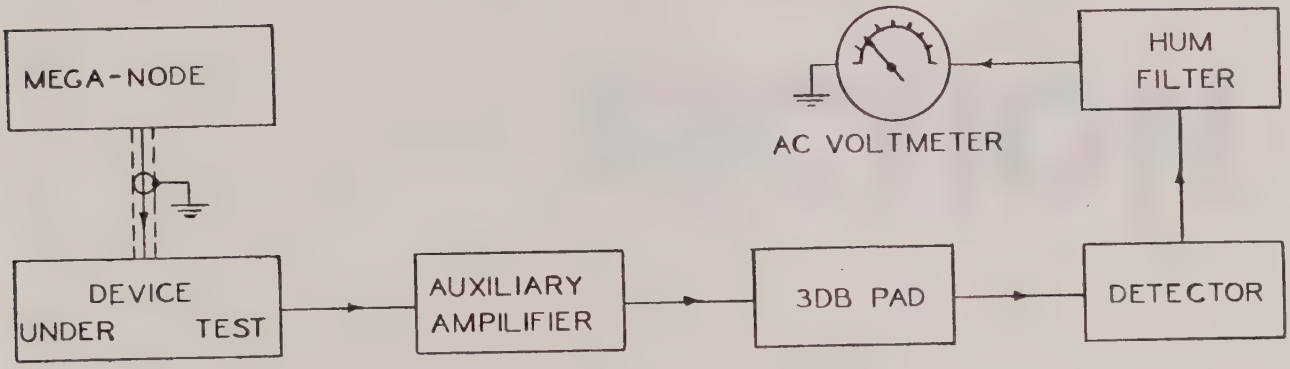


FIG. 3 - INTERCONNECTIONS USING AC VOLTMETER (FOR UNKNOWN LAW)

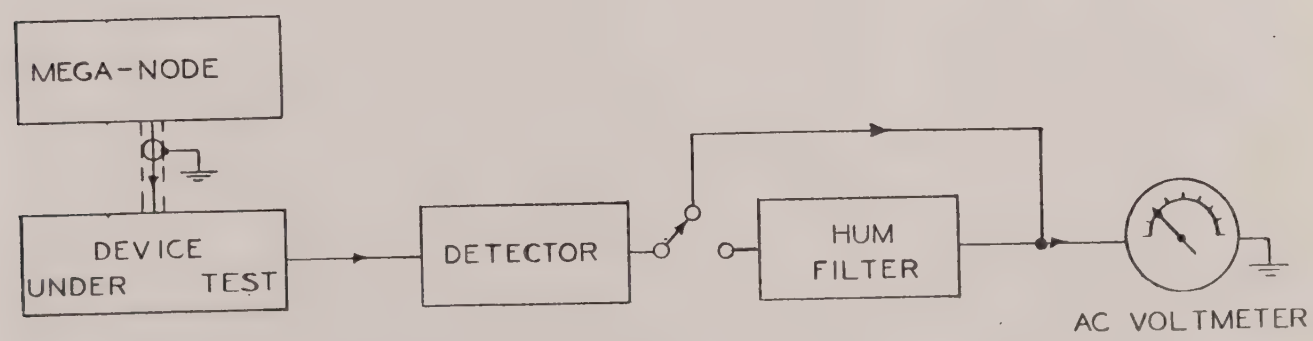


FIG. 4 - INTERCONNECTIONS FOR RELATIVE NOISE MEASUREMENTS

OPERATION SECTION

SECTION III
OPERATION

A. DESCRIPTION OF CONTROLS.

The following is a brief description of the MEGA-NODE operational controls. Detailed instructions for their use are contained later in this section.

1. **POWER** ON-OFF **SWITCH** *(S-1)*. This toggle switch determines the on-off condition of the instrument. When this switch is in the OFF position, all a-c power to the equipment is removed.

2. **OUTPUT SELECTOR SWITCH** *(S-2)*. This triple pole, triple throw, rotary switch controls the range of the noise power output. The NORMAL position permits current from 0 to 10 milliamperes to flow thru the diodes by inserting a resistor in series with the filaments. The STANDBY position turns off all power to the diodes and is primarily used as a separation point between the low and high current positions to prevent harmful current transients. The ADD 10 DB position shorts out the series resistance, allowing the diodes to draw up to 100 ma. It also shunts *R-13* across the meter to maintain calibration.

3. COARSE LEVEL **CONTROL** *(R-1)*. The setting of this potentiometer determines the level of the noise output of the **MEGA-NODE**. Rotating the control clockwise advances the output. The panel meter provides output indication.

4. FINE LEVEL **CONTROL** *(R-2)*. This potentiometer is used in conjunction with the COARSE LEVEL control as a vernier adjustment.

5. **HIGH METER ADJUST CONTROL** *(R-3)*. With COARSE and FINE LEVEL controls fully clockwise, adjust this internal potentiometer until the meter reads full scale with a little overlap.

6. **LOW METER ADJUST CONTROL** *(R-6)*. With COARSE and FINE LEVEL controls fully clockwise, adjust this internal potentiometer until the meter reads full scale with a little overlap. Both outputs should be about equal.

B. NOISE FIGURE MEASUREMENT TECHNIQUES.

The following is a detailed description of the various methods used in performing noise figure measurements with the **MEGA-NODE**. It should be noted that while method #1 and #2 are comparatively simple to perform, it may be necessary to resort to method #4 (Log-Log Method of Evaluating Noise Figure) if the device under test has a noise figure value about 20 db. In employing the first two methods (3 db power increase) the device under test and external amplifier must be capable of supplying a power output of 3 db above the internal noise level without exceeding maximum output capabilities of the last stages of the device under test and the auxiliary amplifier.

1. **METHOD USING CALIBRATED POWER LEVEL METER** *(Refer to Figure 2)*. The output meter employed must be a device capable of indicating random noise power ratios. For best accuracy, it is desirable to use a meter corresponding to rms voltage or current values. It is also best to first determine the linearity of the indicator and auxiliary equipment; this may be accomplished in the following manner:

a. Connect the equipment as shown in *Figure 2*; then, with the **MEGA-NODE**, introduce a noise into the device under test, to provide an output of at least 8 db above the internal noise level of the unit under test. Note the resulting indication on the output meter.

b. Increase the **MEGA-NODE** output 3 db as indicated on the panel meter.

c. The resulting deflection change in the output power indicating device is then a measure of the 3 db change in noise power output from the equipment under test. Note the new output meter reading.

The preceding calibration procedure should be performed with the gain of the system reduced to the point where the operating level of the indicating device is the same as for the ensuing noise figure measurement.

After determining the calibration of the power level measuring device, the noise figure of the device under test may be established. Use the following procedure:

d. With the equipment connected as shown in *Figure 2*, adjust the gain of the auxiliary amplifier to provide an indication on the power level indicating device equal to the value noted in step *a*.

e. Place the **MEGA-NODE** power switch *(S-1)* in the ON position. Rotate the output selector switch *(S-2)* to the NORMAL position.

f. Rotate the COARSE LEVEL control potentiometer until the power level indicating device shows a 3 db increase (doubled power). If additional output is required from the **MEGA-NODE**, rotate the output selector switch to the ADD 10 DB position.

g. Note the db indication on the **MEGA-NODE** meter scale (add 10 db to this reading if the output selector switch is in the ADD 10 DB position). The result is the db noise figure of the device under test. (If the device under test is a superheterodyne receiver, correct for error caused by image response. Refer to paragraph 5 below.)

In using the 3 db power increment method, it is obvious that only noise figure measurements up to 20 db may be read directly on the **MEGA-NODE** meter scale. If, in performing a measurement, maximum output from the **MEGA-NODE** is reached before a 3 db output power increment is observed, the noise figure of the device under test is above 20 db. The actual noise figure (above 20 db) may be computed from the db increase on the power level meter when the maximum output of the **MEGA-NODE** is attained. For example, a power level increment of 1.76 db would indicate a noise figure of 23 db; a power level increment of 0.969 db wound indicate a noise figure of 26 db. Obviously, some loss of accuracy is found when the lower increments are used.

2. METHOD USING FIXED PAD AND AC VOLTMETER. This method is employed when a power level indicating device is not available. In this case, any a-c voltage indicating device may be used; the accuracy of calibration of the device is insignificant. The equipment should be connected as shown in *Figure 3*. (Interconnection data is contained in Section II.) The following is the procedure for determining noise figure:

a. With the fixed pad switched out of the circuit (0 db attenuation), the **MEGA-NODE** OFF, adjust the gain of the auxiliary amplifier so that the internal noise generated in the device under test provides a deflection on the a-c voltmeter. Note this meter indication.

b. Switch in the 3 db pad; place the **MEGA-NODE** power switch in the ON position; rotate the output selector switch to the NORMAL position. Adjust the COARSE LEVEL control potentiometer for an indication on the a-c voltmeter equal to the value noted in step *a* above. (If necessary for increased output, rotate the output selector switch to the ADD 10 DB position.)

c. Note the db indication on the **MEGA-NODE** meter scale (add 10 db to this reading if the output selector switch is in the ADD 10 DB position). The result is the db noise figure of the device under test. If the device under test is a superheterodyne receiver, refer to paragraph 5 below.

3. RELATIVE NOISE MEASUREMENTS. Where the actual noise figure measurement is not required and relative indications of noise values will suffice, the following method may be employed:

a. With the equipment connected as shown in *Figure 4*, adjust the auxiliary amplifier gain so that the internal noise generated in the device under test results in a deflection on the a-c meter. Note this reading.

b. Place the **MEGA-NODE** power switch in the ON position; place the output selector switch *(S-2)* in the NORMAL position. Adjust the noise output, with the COARSE LEVEL control, for an increase in the a-c voltmeter reading. (If necessary, use the ADD 10 DB position.) Note the new a-c voltmeter reading. The indication on the **MEGA-NODE** is then a relative indication.

After circuit changes, etc., are made in the device under test and another noise measurement is made (to show improvement, etc.), a comparative noise reading will be indicated on the **MEGA-NODE** panel meter, providing the original a-c voltmeter readings are maintained.

4. LOG-LOG METHOD OF EVALUATING NOISE FIGURE. This method is useful where the noise figure of the device under test is comparable in value to that corresponding to the maximum output capabilities of the **MEGA-NODE**. It is

also useful in those cases where neither an r-f voltmeter or power meter nor a 3 db attenuator pad is readily available. It involves the use of the output voltage developed by the second detector of the equipment under test (provided the detector is of the diode type) as the measured quantity, thus permiting the use of a d-c type of VTVM such as is commonly available in most laboratories. The set-up of equipment is similar to that shown in *Figure 4*, with the exception that the VTVM (connected across the diode detector load resistor) replaces the hum filter and a-c voltmeter shown.

The procedure is best explained by means of an illustrative example, and the various steps are given below:

a. Set up the equipment as discussed above.

b. With the **MEGA-NODE** OFF and with the amplifier tube just preceding the second detector removed, measure the residual d-c voltage across the detector load resistor. This voltage is caused by combination of "contact potential" and electron initial emission velocities, and its value is to be subtracted from all subsequent voltage readings prior to plotting them. Let us say this voltage reading is 0.3 volts.

c. Replace the amplifier tube removed above, and with the **MEGA-NODE** still OFF and amplification provided if necessary, read the developed detector voltage. This reading should be at least double the previous "residual" reading if the amplification value noted above has been met. Let us say the voltage reading for this step is 0.7 volts.

d. With the **MEGA-NODE** ON, turn the COARSE LEVEL control potentiometer clockwise to give a noise diode d-c plate current of 40 ma. Let us say the output voltage measures 1.3 volts on the VTVM.

e. Turn the COARSE LEVEL control down to give a noise diode d-c plate current of 20 ma and read the second detector VTVM. Let us say this reading is 1.0 volt.

f. Subtract the 0.3 volt "residual" reading of step *b* from each of the subsequent readings (steps *c*, *d*, and *e*). This gives readings of 0.4, 1.0 and 0.7 volts, respectively.

g. Using log-log graph paper with **MEGA-NODE** current as the abscissa and second detector voltage as the ordinate, plot a horizontal line at the 0.4 volt level as a reference base line, and plot the 0.7 volts, 20 ma., point and the 1.0 volt, 40 ma., point as shown at A and B respectively in *Figure 5*.

h. The problem is to find now by graphical trial-and-error and incremental noise diode current value which, when added equally to points A and B, yields a new pair of points, a straight line through which then intersects the REFERENCE BASE LINE at a current value exactly equal to the incremental current value.

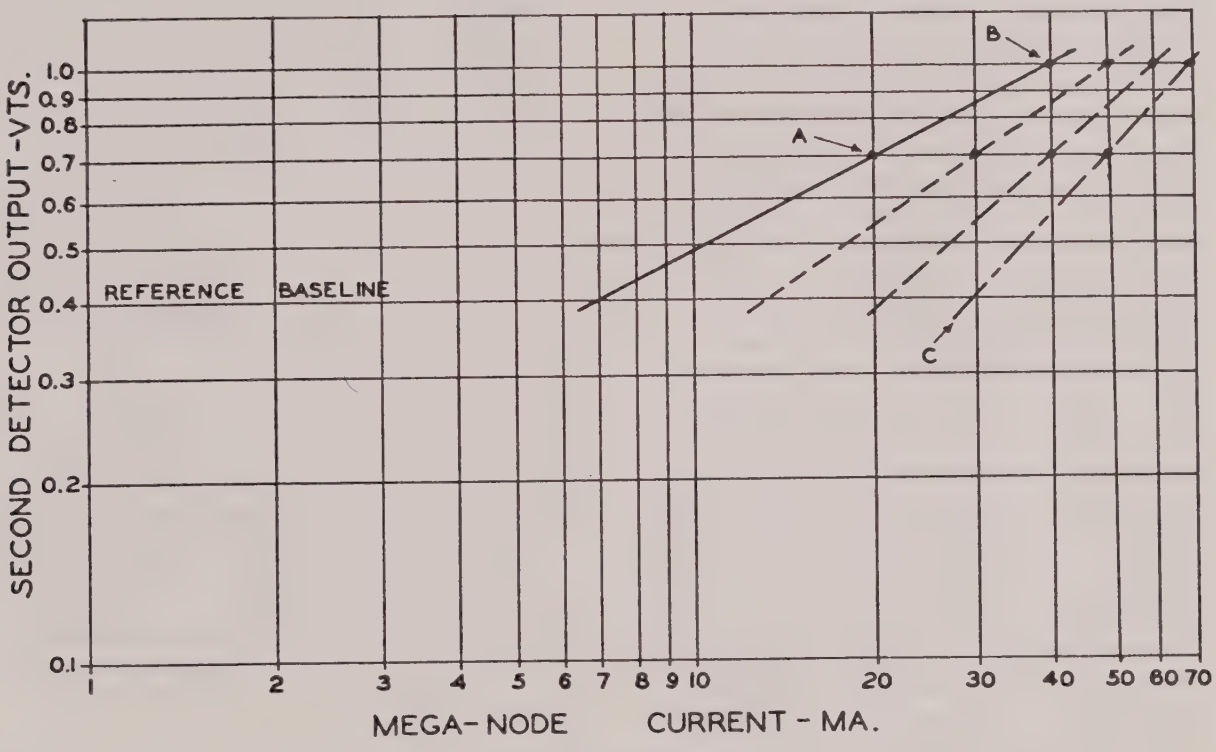
i. Let us first try an incremental current value of 10 ma. When this value is added equally to points A and B, we get two new points (0.7 volt, 30 ma. and 1.0 volt, 50 ma.). A straight line intersects the REFERENCE BASE LINE at about 13.4 ma., which is larger than the chosen incremental value. This indicates that a larger incremental value should be tried.

j. Trying an increment of 20 ma., we get points 0.7 volt, 40 ma. and 1.0 volt, 60 ma. A straight line through these points (the long-dashed line in *Figure 5*) produces an intercept at about 21.5 ma. A still larger incremental value must therefore be chosen.

k. Trying an increment of 29 ma., we get points 0.7 volt, 49 ma., and 1.0 volt, 69 ma. A straight line through these points (the long-short dashed line in *Figure 5*) intersects the REFERENCE BASE LINE at exactly 29 ma., corresponding to the incremental value chosen. This is the correct value of noise diode current to use in calculating the Noise Figure of the device under test. At the same time, the slope of the final plotted line directly gives the rectifier power law of the second detector used in the set-up when it is noted that this final line is essentially that of rectified detector output voltage versus total noise power applied to the detector. A 45 degree slope (i.e., tan = 1) would thus indicate that the detector was of the so-called "square law" type, while a 26.6 degree slope (i.e., tan = 0.5) would indicate a linear detector.

5. CORRECTION FOR SUPERHETERODYNE RECEIVER. In measuring the Noise Figure of a superheterodyne receiver, a correction must be applied to the current reading obtained. Since the MEGA-NODE produces noise at both the signal and the image frequencies, the correction factor must be such as to give the d-c generator current that doubles the noise output power if there had been no image response. If A and B are the average power gains at signal and image frequencies, respectively, the multiplying factor is:

$$\frac{A}{A - B}$$



NOISE MEASUREMENT

Figure 5. Log-Log Graphical Noise Measurement.

SECTION IV
THEORY OF OPERATION

A. NOISE MEASUREMENT THEORY.

The "noise diode" method of measuring receiver Noise Figures is quite fundamental and permits simplification in procedure and greater accuracy than other methods. Techniques employing a continuous-wave signal generator are subject to a noticeable error in the measurement of the extremely small power levels employed, especially at the higher frequencies, and a separate measurement of receiver bandwidth is required. The use of a temperature-limited diode as a noise generator permits cancellation of the bandwidths involved, since the diode noise is distributed the same as the receiver noise with respect to frequency. This method, therefore, required no measurements or knowledge of bandwidth or gain. The mean squared noise current supplied by the diode is proportional to the d-c plate current which can be easily and accurately measured.

1. NOISE FIGURE MEASUREMENTS. Any receiver, other than a hypothetical ideal receiver, will have noise generated within the receiver itself in addition to the noise supplied by the signal source. The Noise Figure is a figure of merit by which the noise of a given receiver system is compared with that of an ideal receiver in a similar system but having the same bandwidth. The noise supplied to the ideal receiver by the signal source will be

$$e_t^2 = 4KTR_a\Delta f \qquad (1)$$

Where:

e_t^2 = Open-circuited mean squared thermal noise voltage.
K = Boltzmann's constant, 1.37×10^{-23} joules/°K.
T = Temperature of resistance in °K.
R_a = Internal resistance of the source in Ω
Δf = Receiver noise bandwidth in cps.

The noise present in the given receiver will be that supplied by the signal source plus the noise generated within the receiver itself. The noise generated within the receiver may be referred to the signal source as a mean squared noise voltage. Call this voltage e_n^2.

Then by definition:

$$\text{Noise Figure} = F = \frac{e_n^2}{e_t^2} \qquad (2)$$

To determine e_n^2 the "noise diode" is connected to the receiver through the signal source impedance, R_a. With the noise source turned off, the noise power output of the receiver is measured. Then the noise source is turned on and the diode direct plate current is increased from its lowest value to that value which just doubles the receiver noise power output. The mean squared noise current of the diode is given by

$$i^2 = 2eI_b\Delta f \qquad (3)$$

Where:

i = Root mean squared noise current in amps.
e = Charge on electron (1.59×10^{-19} coulombs).
I_b = D.C. diode plate current in amperes.
Δf = The noise bandwidth of the receiver in cps.

The mean squared voltage developed by this noise current across the internal impedance of the source (R_a) will be

$$e_n^2 = (iR_a)^2 = 2eI_b \Delta f R_a^2 \qquad (4)$$

Substituting equations (1) and (4) in equation (2)

$$F = \frac{eI_bR_a}{2KT} \qquad (5)$$

It is usually permissible to assume T to be room temperature; i.e., 288° Kelvin, 17°C., 63°F., in which case equation (5) reduces to:

$$F = 20I_bR_a \qquad (6)$$

Variation of this reference temperature between 270°K and 300°K ordinarily will affect the Noise Figure by less than about ±5%, which is equivalent to ±0.2 db. The value of F given by (6) is a power ratio. It may be expressed in db by the relationship:

$$F_{db} = 10 \log_{10} F \qquad (7)$$

2. REQUIREMENTS OF THE NOISE DIODE GENERATOR.

a. Resistor R_a, which is taken as the internal impedance of the signal source, must be constant over the noise bandwidth of the unit under test.

b. The "Noise Diode" must be fully temperature limited. This is a condition of equation (3) and it is well to observe that the a-c plate resistance of the diode, which shunts R_a, is sufficiently high to be negligible only when the diode is completely temperature limited. This condition is met in the MEGA-NODE for all values of diode d-c plate current less than 100 ma.

3. CONDITIONS OF MEASUREMENT. It is important that the output indication corresponds to random noise rather than to hum. A convenient method for checking this is to short circuit the output of the last tube which contributes significant noise to the system. The output indication should fall to zero. This test will not account for hum components introduced prior to the short circuit. However, such hum components are normally small enough not to affect the measurement. Their presence, if suspected, may be determined by the temporary introduction of additional filtering or the observation of the noise output on a high gain oscilloscope. The use of bridge type hum filters, 60 and 120 cycle, may be desirable and helpful.

a. All stages prior to the indicator must be linear and overload must not occur with even the highest noise input it may be necessary to employ.

b. There must be sufficient overall gain in the noise figure measurement set-up to produce across the terminals of the output indicating device enough energy attributable to the effective input noise sources in the device under test to give a usable output reading or deflection. For overall bandwidths of the order of 4 mc., this will generally require at least 80 db of overall gain.

B. DETAILED METHOD OF NOISE FIGURE MEASUREMENT ON TELEVISION RECEIVERS.

1. MEASUREMENT TECHNIQUE. In order to use the MEGA-NODE it is necessary to read the output power of the system. This cannot be done with a peak or average reading instrument even though it is calibrated .707 peak and called an rms meter. Because power is directly proportional to the mean square voltage, a thermal type indicator is the best output measuring device. In the case of a television receiver, the noise power is conveniently measured at the output of the IF amplifier before the signal has been detected. An instrument well suited for this work is a sensitive bolometer. Although noise figure measurement of the tuner alone is desired, it is necessary to raise the noise power output level for purposes of measurement. This can be done most nearly approximating conditions of tuner operation by using a television IF amplifier. To avoid obscuring the noise measurement of the front end, the IF amplifier should be relatively free of noise and regeneration. Setting of the "fine tuning" control may also vary the noise figure to a slight degree. For purposes of standardization the tuner should be adjusted to the center of the television channel using a sweep signal generator.

Actual measurement is made with the instruments arranged as shown in *Figure 6*.

a. Apply operating voltages to all units.

b. With a sweep signal generator, set the tuner at the center of the channel.

c. Set the COARSE and FINE LEVEL controls of the MEGA-NODE at minimum (fully counterclockwise).

d. Adjust the bolometer unit to measure output noise power; turn OFF the MEGA-NODE.

e. Read noise output power.

f. Turn the MEGA-NODE ON and increase the output level until the power indication of the bolometer is exactly doubled. Turn the MEGA-NODE OFF to check the original noise power and if necessary, recheck the zero of the bolometer. When "turning on" the MEGA-NODE just doubles the bolometer reading, the noise figure may be read from the MEGA-NODE directly in decibels. Check the meter-scale knob and add 10 db if necessary.

2. PRECAUTIONS FOR ACCURACY. In order to insure accuracy of measurements on high gain systems, it is necessary to observe several precautions.

a. FEED-BACK. There must be no feed-back in the system not present under normal operating conditions. The barreter for the bolometer bridge should be placed very close to the last amplifier tube in the IF strip, and connection to the bridge from the barreter should be made with shielded cable. Shielding should be as effective as possible.

b. PICKUP. Since the system to be measured has extremely high gain, the presence of any high-frequency fields, particularly those of nearby television stations, can cause inaccuracy. In order to reduce this possibility, measurement should be made in a screen-room. If this is impossible, the output should be checked carefully to make certain that only thermal noise is present.

c. BIAS AND AUTOMATIC VOLUME CONTROL. The automatic biasing controls of the tuner and IF amplifier should be disabled. Normal bias present at zero signal input (for purposes of standardization) should be applied to the tubes from a battery supply. Bias supplies operating from power lines are not desirable because of likelihood of high noise voltages and the possibility of pickup and hum.

d. HUM. Introduction of hum in the system can completely mask noise voltages and must be avoided. This is aided by a coupling network with poor low frequency response used to supply power to the barreter.

e. IF AMPLIFIER NOISE. While the usual Tuners and IF amplifiers associated with television receivers will not give trouble from this cause, it is possible for an extremely noisy IF amplifier to control the noise-figure of the system, rather than the tuner. This can be quickly checked by measuring the output noise with the MEGA-NODE turned OFF; then remove plate voltage from all tubes in the tuner, still

allowing the IF amplifier to function. The noise power under these conditions should be very much smaller than the normal operating noise output of the system.

f. LIMITING. A check should be made to ascertain that the noise is not limited by overloading of the IF amplifier. Operation in the linear region is essential for accurate measurements.

g. AC-DC TUNERS. A line isolating transformer should be used for tests of AC-DC equipment.

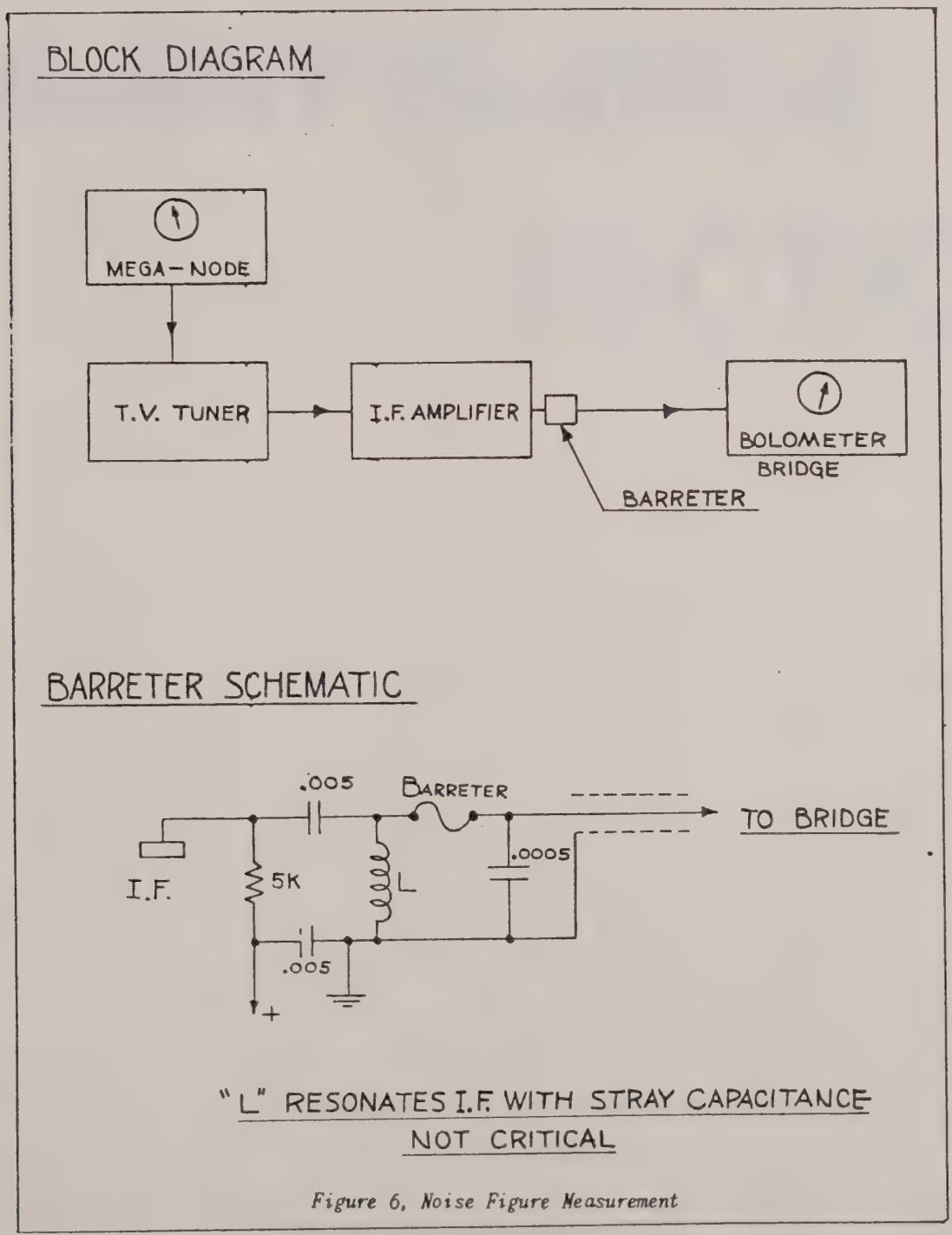


Figure 6, Noise Figure Measurement

MAINTENANCE SECTION

SECTION V
MAINTENANCE

A. INTERNAL ADJUSTMENTS.

The following chassis adjustments, although factory-set, may require attention after diode aging, component replacement, etc. The following procedure should be used in setting these controls.

1. **PRESET HIGH** *(R-3)*. This control should be set to provide a slightly more than full-scale reading on the panel meter when the COARSE and FINE LEVEL adjustments are fully clockwise and the output selector switch is in the ADD 10 DB position.

2. **PRESET LOW** *(R-6)*. This control should be adjusted with the output selector switch in the NORMAL position. Adjust *R-6* for a slightly more than full-scale panel meter deflection when the COARSE and FINE LEVEL adjustments are fully clockwise.

CAUTION: When operating the unit in the ADD 10 DB *position, the red mark on the meter indicating 10 ma should not be exceeded except momentarily, as when adjusting R-3, to lengthen the life of the diodes.*

3. **METER MULTIPLIER ADJUSTMENT** *(R-13)*. This control is initially factory-set (and soldered in place) for the correct meter calibration. Should any component in the meter circuit be replaced, unsolder and reset *R-13* for the correct meter calibration in the ADD 10 DB position. An external 0-100 ma. d-c meter should be connected in series with the plate supply to the noise diode; the panel meter may be calibrated using the external meter as a standard.

B. TROUBLE LOCATION.

In case of failure, it is advised to first be sure the difficulty is not with the circuit under test, the auxiliary equipment or interconnecting cables. For location of trouble in the **MEGA-NODE**, the following table should be of aid:

TROUBLE LOCATION CHART	
SYMPTOM	**PROBABLE CAUSE AND CORRECTION**
Equipment fails to operate when OFF-ON switch is in ON position.	*S-1* open; *F-1* blown. If new fuse also blows, check *T-1*, *T-2* and rectifiers.
Zero meter indication. B+ indicator lamp indicates normally; no output from instrument.	Check diodes; check diode plate voltage; if zero, check plate supply components. Check *R-9*, *R-10*.
Zero meter indication; B+ indicator lamp indicates normally. Normal noise output from instrument in ADD 10 DB position. No output in NORMAL position.	Check meter for open.
Lower than normal meter indication in either switch position.	Check bridge rectifier components. Check plate supply voltage and secondary voltage of *T-1*. Check *C-1* and *C-2*. Check *V-1* and *V-2* for low emission.

PARTS LIST

SECTION VI
PARTS LIST

RESISTORS: (UNLESS OTHERWISE SPECIFIED, ALL COMPONENTS ARE FIXED, ½ WATT, COMPOSITION, 10% TOLERANCE RESISTORS.)

R-1	250, 25 WATTS, VARIABLE COARSE (EXT.)
R-2	50, 4 WATTS, VARIABLE, FINE (EXT.)
R-3	100, 2 WATTS, VARIABLE, PRESET HIGH (INT.)
R-4	47, 2 WATTS
R-5	100, 5 WATTS
R-6	60, 2 WATTS, VARIABLE, PRESET LOW (INT.)
R-7	47, 2 WATTS
R-8	100K
R-9	220, 1 WATT
R-10	220, 1 WATT
R-11	100, 1%, SPECIAL
R-12	100, 1%, SPECIAL
R-13	5, 1½ WATTS, VARIABLE, METER ADJUST

CAPACITORS: (ALL CAPACITANCE IN $\mu\mu f$ UNLESS OTHERWISE SPECIFIED.)

C-1-2	20μf x 450V, DUAL ELECTROLYTIC
C-3	2300, CERAMIC, FEED THRU
C-4	2300, CERAMIC, FEED THRU
C-5	2300, CERAMIC, FEED THRU
C-6	2300, CERAMIC, FEED THRU
C-7	0.01μf, 600V, OIL, FEED THRU
C-8	0.01μf, 600V, OIL, FEED THRU
C-9	2000μf, 15V, ELECTROLYTIC
C-10	6800 (MODEL 403-A ONLY)

MISCELLANEOUS:

D-1	RECTIFIER, SELENIUM, RR 44 S1C1S1G
D-2	RECTIFIER, SELENIUM, SIEMEN B125 C125
F-1	FUSE, 1 AMP, 3AG
I-1	LAMP, NEON, G.E. NE51, 115V
J-1	OUTPUT JACK (50Ω FOR MODEL 403-A & 300Ω FOR MODEL 175-A)
L-1	CHOKE, BIFILAR
M-1	METER, 10 MA, SIMPSON MODEL 29
P-1	POWER LINE PLUG
S-1	SWITCH, TOGGLE, SPST, ON-OFF
S-2	SWITCH, ROTARY, 3P3T, OUTPUT SELECTOR
T-1	TRANSFORMER, REGULATING, SOLA 20-13-060
T-2	TRANSFORMER, FILAMENT, SNC 2393
V-1	5722, SYLVANIA TUNGSTEN FILAMENT DIODE
V-2	5722, SYLVANIA TUNGSTEN FILAMENT DIODE

9/9/58

ADDENDA

MEGA-NODE MODELS 175-A & 403-A

(Pertains to Mega-Node Instruments above Serial No. 21331)

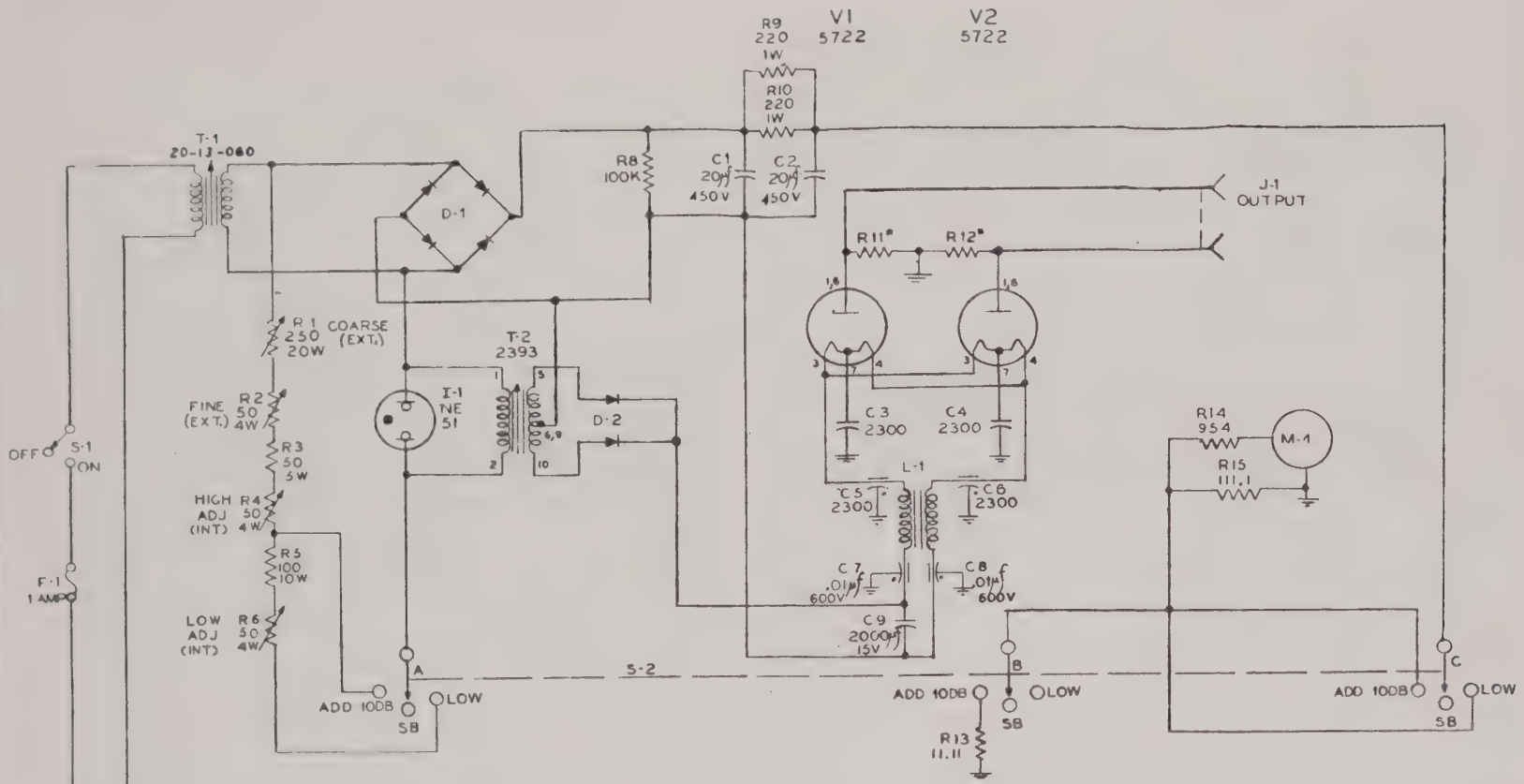
REFERENCE	CHANGE
Page 1, column 2, Section D, item 3.	The Hum Filter as referenced here and elsewhere in the manual, is an optional item. The filter may, or may not be required, depending on circumstances as related in paragraphs 3 and 4, page 2, column 2. When the filter is used, it should be connected between the detector and the output indicator.
Page 2, column 2, Section B, paragraph 4	Delete words "connect as shown in Figure 3".
Page 3, add new figures 2, 3 & 4.	Block diagrams of Equipment Interconnections.
Page 4, column 1, item 5.	Change R-3 to R-4.
Page 11, column 1, item 1	Change R-3 to R-4.
Page 11, column 1, item "caution".	Change R-3 to R-4. Change 10 ma to 70 ma.
Page 11, column 2, item 3.	Delete "soldered" and insert "cemented".
Page 12, Parts List:	The following changes apply:
Resistors	R-1 change 25 watts to 20 watts. R-3 change 100 ohms to 50 ohms, change 2 watts to 5 watts. R-4 change 47 ohms to 50 ohms, change 2 watts to 4 watts. R-5 change 5 watts to 10 watts. R-6 change 60 ohms to 50 ohms, change 2 watts to 4 watts. R-7 delete, not used. R-13 change 5 ohm, to 1 ohm, change 1.5 watts to 4 watts.
Capacitors	C-1, C-2 change 20μf x 450V to read 20 x 20μf, 450V

Note: Component value and wattage changes apply to both schematics shown in Figures 7 and 8. New schematics No.KB-5492-C and KB-5643-B now apply.

(Pertains to Mega-Node Instruments above Serial Number 21986)

REFERENCE	CHANGE
Page 11	The 10-mil meter is replaced by a 1-mil meter (Kay Part #1947 BX in combination with R-14, R-15) in instruments above serial number 21986. The variable meter shunt (R-13) associated on the Add 10 DB position of S-2, has been replaced with a precision fixed resistor of 11.11 ohms. Instructions given in Part 3 of Section V, (Meter Multiplier Adjustment R-13), should be deleted, since R-13 is now a fixed precision resistor
Page 12, Parts List Resistors	(Schematic KB-5492-D & KB-5643-C) R-13 change 5 ohms to 11.11 ohms change 1½ watts variable to ¼ watt fixed Add R-14, 954 ohms, ¼ watt. Add R-15, 111.1 ohms, ¼ watt.

SCHEMATICS



NOTE:
UNLESS INDICATED OTHERWISE
RESISTANCES ARE IN OHMS
CAPACITANCES ARE IN μμf
FACTORY SELECTED *

SCHEMATIC	MODEL 175 A	MEGA - NODE
MAT.	FINISH:	SCALE:

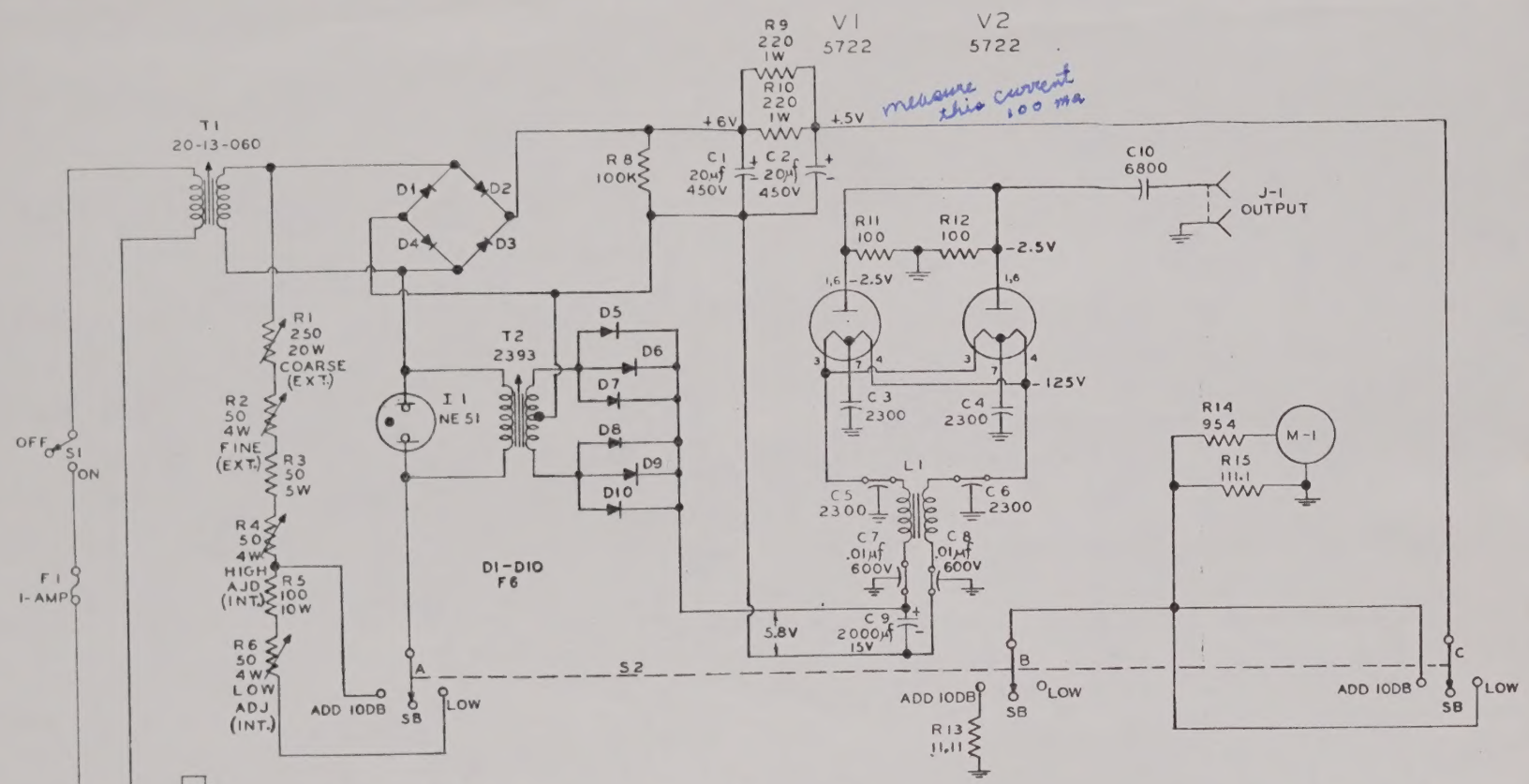
DIMENSIONS TOLERANCES UNLESS OTHERWISE SPECIFIED:
DECIMAL DIMENSIONS ± .002 FRACTIONAL DIMENSIONS ± .008

KAY ELECTRIC CO.
PINE BROOK, N. J.

CHANGE	DATE	APP.
"A" added Coarse & Fine Ext		
"B" ECN 408		
"C" ECN 645		
"D" ECN No 942		

DWN. BY Joseph Pierce DATE 11/4/57
APP. BY C. J. Franks DATE 11/4/57

DWG. NO. KB 5643 D



NOTE

① UNLESS INDICATED OTHERWISE ALL RESISTANCES ARE IN OHMS ALL CAPACITANCES ARE IN μμf.

② VOLTAGES TAKEN WITH RESPECT TO CHASSIS GROUND AND WITH 50 MA[17.0 DB NOISE FIGURE] THRU V1 AND V2. VOLTAGE ACROSS C9 TAKEN WITH VTVM FLOATING.

SCHEMATIC	MEGA-NODE MODEL 403A	
MAT.	FINISH:	SCALE:
DIMENSIONS TOLERANCES UNLESS OTHERWISE SPECIFIED: DECIMAL DIMENSIONS ± .002 FRACTIONAL DIMENSIONS ± .005	KAY ELEMETRICS CORP PINE BROOK, N. J.	
CHANGE	DATE	APP.
"B" added COARSE & FINE EXT	9/6/57	C.J.F.
"C" ECN No 402	6-25-57	C.J.F.
"D" ECN No. 605	7-31-57	C.J.F.
"E" ECN No 942	9/16/57	C.J.F.
"F" ADDED VOLTAGES AND NOTES PER ECN 1459	9/17/57	C.J.F.
"G" PER ECN #1647	9-27-57	C.J.F.
DWN. BY Joseph Pierce	DATE 11/4/57	
APP. BY C. J. Franas	DATE 11-4-57	
DWG. NO. KB 5492G